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Québec Region

Canadian Science Advisory Secretariat
Science Advisory Report 2017/024

ASSESSMENT OF SOFTSHELL CLAM STOCKS IN QUÉBEC COASTAL WATERS

S. Brulotte, DFO, Québec Region, 2012.

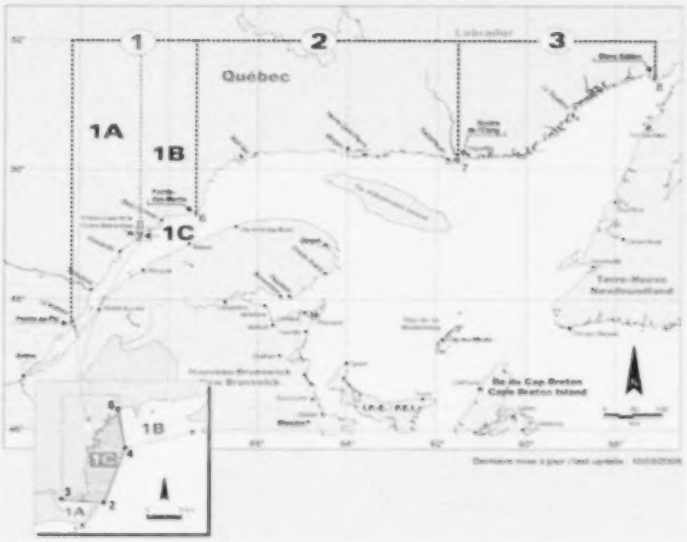


Figure 1. North Shore softshell clam fishing areas.

Context:

Softshell clams are found along most of Québec's shoreline. Recreational harvesting of softshell clams has a long history in Québec, but this activity is poorly documented. The fishery expanded along the North Shore in the 1970s and peaked in the year 2000. This type of harvesting has been practised almost exclusively on the Upper North Shore since 1993. Upper North Shore commercial activities are regulated by the number of licenses, a minimum legal size, a season and a landings quota by shellfish area. For recreational harvesting, management tools include the season, the minimum legal size and the number of softshell clams harvested per day. Only hand tools are permitted for softshell clam harvesting. The main indicators used for monitoring stocks are landings, fishing effort, catch per unit effort (CPUE), demographic structure and research surveys.

At the request of the Fisheries Management Branch, resource assessment is done every three years. Due to the low amount of fishing activity in the early 2010s, the review of the status of clam stocks scheduled for 2014 did not take place. This Science Advisory Report is from the meeting of February 16, 2017, on the Assessment of Softshell Clam Stocks in Québec Coastal Waters.

June 2017

Canada

SUMMARY

- Softshell clams are present along most of Québec's shoreline in beds in soft-bottom sediments. They are exploited by commercial and recreational harvesters. The quantities that are harvested recreationally, an activity valued by coastal communities, remain unknown.
- There is no commercial fishery in the Gaspé Peninsula and the Lower St. Lawrence. Landings from the Îles-de-la-Madeleine are low (< 1.3 t) and it is difficult to assess the status of the resource in that location.
- Since 2010, clam landings have come mainly from 11 shellfish areas in sub-areas 1A, 1B and 1C of the Upper North Shore.
- Landings reached a maximum of 1,173 t in 2000 on the Upper North Shore. They then declined to 190 t in 2009, a year prior to the closure of the processing plants. After a few years of low landing numbers, they rose somewhat in 2015 following the re-opening of a plant. Landings amounted to 72 t in 2015 and 83 t in 2016. Total allowable catches (TACs), introduced in 2015, were not met for the vast majority of areas, despite a good price.
- The measure of fishing effort in vendor-day is somewhat uncertain because there may have been more than one harvester per seller, mainly during the intensive exploitation of the early 2000s. This uncertainty also affects the catch per unit effort (kg/vendor-day).
- In 2015 and 2016, the average size of clams landed was between 58 and 74 mm in the exploited areas. The proportion of clams of sub-legal size (< 51 mm) was generally below 5%. However, this proportion was about 10% for the Anse du Colombier, Anse Noire and Îlets Jérémie areas in sub-area 1A.
- The survey conducted in 2014 on the Reserve Pessamit Sud bed suggests a stable density and biomass of legal-size clams compared to the 2010 survey. Surveys were taken in 2016 on the Banc Marie-Marthe and the Baie des Plongeurs. The closure of the Baie des Plongeurs from 2010 to 2015 appears to have favoured the recovery of this bed.
- Despite the low commercial fishing effort in recent years, several areas (e.g. Pointe à Boisvert and Pointe de Mille-Vaches) have not shown a significant improvement in the status of their resources.
- In order to protect the reproductive potential of each shellfish area, it is recommended to collect less than 10% of the commercial biomass annually. To mitigate the incidental mortality caused by the fishery, it is recommended to prohibit any harvesting when the air temperature is ≤ 0 °C.

BACKGROUND

Biology

Softshell clams, *Mya arenaria*, are bivalve molluscs found in North American and European coastal waters. On the Atlantic west coast, their range extends from Labrador to Cape Hatteras, in North Carolina. This shellfish is found in the intertidal zone in the Estuary and Gulf of St. Laurence and in Chaleur Bay. It is an endobenthic organism that lives buried in loose sand and silt sediment. A sedentary species, it lives in groups of varying sizes called "beds." Clams feed on plankton and suspended particles in the water. In Québec, clams take five to seven years to reach the minimum legal size of 51 mm and their size can exceed 110 mm.

Clam sexes are separate and the sex ratio is usually even. The mean size at which 50% of individuals are sexually mature is 38-39 mm in Québec. There is only one spawning period per year that occurs mainly in June and July. Gametes are released into the water and fertilization occurs outside the shell. After a larval phase of about five weeks, the clam transforms, takes on its adult form and becomes established on the sea bed.

Harvesting activities and the action of waves and storms can deplete the clams. Tank and field tests showed that the time clams require to bury themselves is primarily influenced by the size of the clams and water temperature. Clams that are 15-20 mm bury themselves more quickly than 35-40 mm clams. In addition, the speed of burial is inversely proportional to the temperature of the water. At 20 °C, a 15-20 mm clam takes approximately 1 hour to bury itself completely, while at 5°C, it takes over 7 hours.

The burial depth of the soft-shell clam is twice its length. Juveniles (< 10 mm) bury themselves in the top few centimeters of sediment. Experiments conducted on sandy and silty flats show that the rate of dispersal (or loss) is influenced by the size of the clams and sediment type. The highest loss rates were recorded for 15-20 mm clams in sandy sediments.

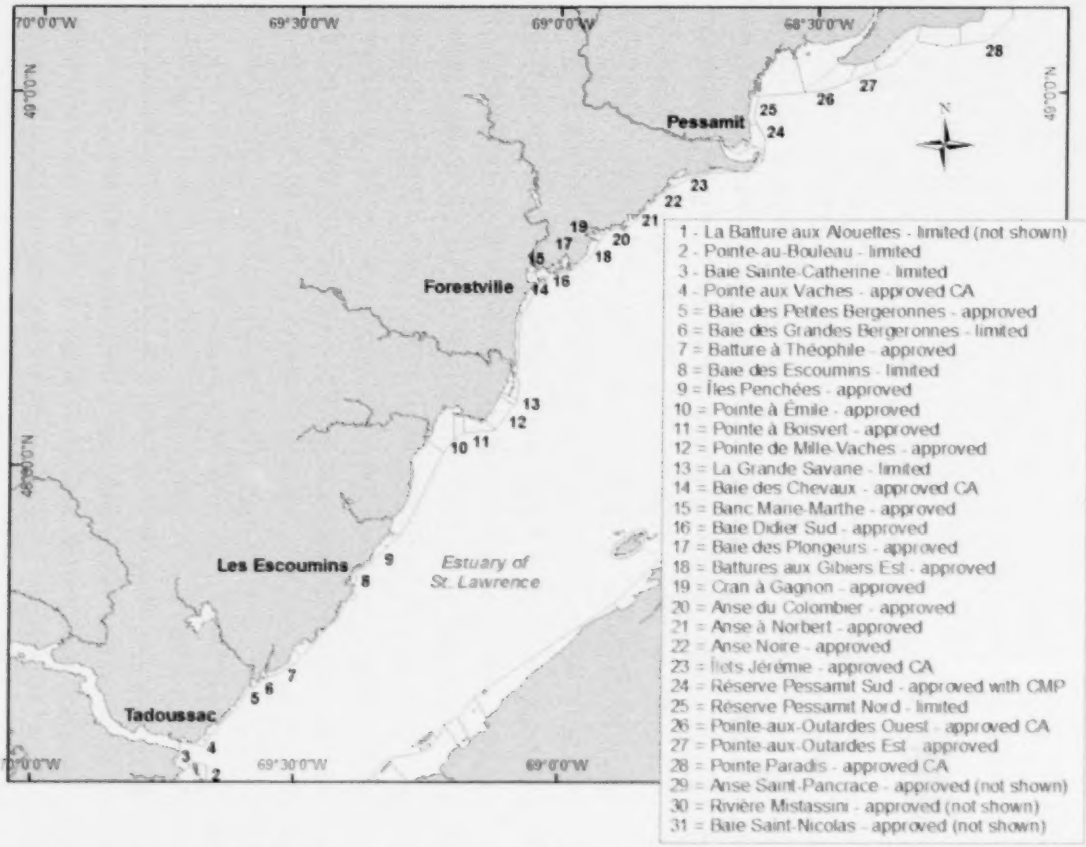
Generally, recommended conservation measures for this species aim to ensure the sustainability of each bed by maintaining its reproductive potential.

General description of the fishery

Softshell clam harvesting is very popular among people in the maritime regions of Québec, because the resource is easily accessible and can be harvested without the use of specialized equipment. Commercial and recreational harvesting take place on the same coastal territory. These two activities are practised at low tide, primarily during spring tides. Maritime Québec is divided into three large regions: the North Shore, Gaspé–Lower St. Lawrence and the Îles-de-la-Madeleine. The North Shore is divided into three harvesting areas: area 1 (sub-areas 1A, 1B and 1C) corresponds to the Upper North Shore, area 2 to the Middle North Shore and Area 3 to the Lower North Shore (Figure 1).

Coastal zones are divided into shellfish areas. In Québec, as everywhere in Canada, shellfish areas are managed by the Canadian Shellfish Sanitation Program, which annually determines the classification in each area. Approved shellfish beds are open to clam harvesting, and those conditionally approved are closed from June 1st to September 30th. Limited status areas are accessible to commercial harvesting on the condition that the clams undergo a depuration treatment at a processing plant before consumption. No harvesting is permitted in the areas with prohibited status.

In 2016, the Upper North Shore included 64 shellfish areas, including 18 approved areas, 5 conditionally approved areas, 1 approved area with a conditional management plan (Réserve Pessamit Sud), 7 limited status areas and 33 areas with prohibited status (Figure 2). In 2016, there were 33 approved or conditionally approved shellfish areas in the Îles-de-la-Madeleine, 7 in Gaspé–Lower St. Lawrence and 23 in the Middle North Shore and Lower North Shore.


70°0'0"W
69°30'0"W
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Pessamit
Forestville
Les Escoumins
Tadoussac
Estuary of St. Lawrence
1 - La Batture aux Alouettes - limited (not shown)
2 - Pointe-au-Bouleau - limited
3 - Baie Sainte-Catherine - limited
4 - Pointe aux Vaches - approved CA
5 = Baie des Petites Bergeronnes - approved
6 = Baie des Grandes Bergeronnes - limited
7 = Batture à Théophile - approved
8 = Baie des Escoumins - limited
9 = Îles Penchées - approved
10 = Pointe à Émile - approved
11 = Pointe à Boisvert - approved
12 = Pointe de Mille-Vaches - approved
13 = La Grande Savane - limited
14 = Baie des Chevaux - approved CA
15 = Banc Marie-Marthe - approved
16 = Baie Didier Sud - approved
17 = Baie des Plongeurs - approved
18 = Battures aux Gibiers Est - approved
19 = Cran à Gagnon - approved
20 = Anse du Colombier - approved
21 = Anse à Norbert - approved
22 = Anse Noire - approved
23 = Îlets Jérémie - approved CA
24 = Réserve Pessamit Sud - approved with CMP
25 = Réserve Pessamit Nord - limited
26 = Pointe-aux-Outardes Ouest - approved CA
27 = Pointe-aux-Outardes Est - approved
28 = Pointe Paradis - approved CA
29 = Anse Saint-Pancrace - approved (not shown)
30 = Rivière Mistassini - approved (not shown)
31 = Baie Saint-Nicolas - approved (not shown)

Figure 2. Location of shellfish areas with approved status, conditionally approved (CA) status, approved status with conditional management plan (CMP) and limited status in area 1 of the Upper North Shore.

In Québec, the minimum legal size is 51 mm for clams regardless of the type of harvest. Harvesting is done exclusively using hand tools (clam fork, shovel, etc.), except in the Middle North Shore (Area 2) where there are two commercial hydraulic dredge harvesting licences (inactive for several years). In addition, recreational harvesters cannot harvest more than 300 clams per day. Commercial harvesting is permitted in the Upper North Shore and the Îles-de-la-Madeleine.

Starting in 2002, management measures have been implemented gradually in the Upper North Shore to control the commercial manual harvest. To the minimum legal size and type of fishing gear authorized were added a maximum number of licenses, a fishing season, a participation clause and the requirement to wear a safety vest and keep a logbook. A total allowable catch (TAC) for commercial harvesting was implemented in 2015 in the approved and conditionally approved areas and the approved area with conditional management plan (Table 1). Sub-area 1C is controlled by the Innu aboriginal community of Pessamit with just one licence. Since 2009, the Baie des Chevaux, Banc Marie-Marthe, Baie Didier Sud, Baie des Plongeurs and Cran à Gagnon have been reserved exclusively for commercial harvesting. Two sectors were closed in 2010 to ensure the conservation of reproductive potential: Baie Didier Sud and Baie des Plongeurs. These areas were opened in 2016 with a limited season of about 13 days. The Baie des Petites Bergeronnes area (situated in the Saguenay–St. Laurence Marine Park) is open for

a spring recreational harvest that lasts a few weeks. In the Îles-de-la-Madeleine, commercial harvesting is managed by a fishing season and the obligation to complete a logbook.

Commercial fishery statistics are quite well documented and known for all shellfish harvesting areas since 2002, whereas the quantities harvested recreationally are not documented.

ASSESSMENT

Commercial harvesting

Since 1970, commercial harvesting has been done mainly on the North Shore (Figure 3). In the Îles-de-la-Madeleine, landings have been low (< 1.3 t) for several years and it is difficult to assess the status of this resource. There has been no commercial harvest in the Middle North Shore, the Lower North Shore, the Lower St. Lawrence or Gaspé since 2008.

Commercial softshell clam harvesting expanded to the North Shore in the 1970s and it has taken place primarily on the Upper North Shore since 1993 (Figure 3). From 1993 to1999, landings on the Upper North Shore fluctuated between 289 and 745 t. They reached a peak of 1,173 t in 2000 and declined sharply afterwards. Landings from 2007 to 2009 amounted to between 176 and 289 t. From 2010 to 2014, landings were low (11 to 57 t) owing to the absence of processing plants in the region (Table 1). There was a resumption of commercial activities in 2015 with the re-opening of a plant in Forestville. Landings for the two years were 72 and 83 t.

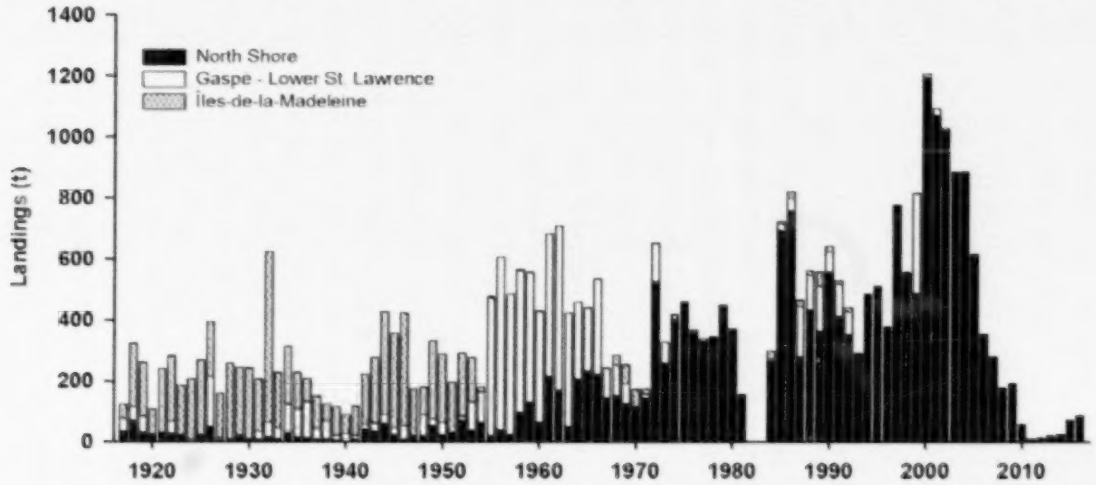

Figure 3. Softshell clam commercial landings by Québec region.

The division of landings between sub-areas 1A, 1B and 1C has varied over the years (Figure 4). From 2002 to 2005, landings came mainly from sub-area 1A. After that, the contribution of that sub-area gradually declined until 2009. Landings in sub-area 1B, although less significant, have followed the same trend. In sub-area 1C, apart from the high values in 2004 and 2005, landings have remained relatively stable until 2009. From 2010 to 2014, most of the landings came from the east and west Pointe-aux-Outardes areas (sub-area 1B). In 2015 and 2016, landings from sub-area 1A returned to the level of 2007 to 2009. Since 2010, landings of softshell clams have come mainly from 11 shellfish area sub-areas 1A, 1B and 1C: Baie des Chevaux, Banc Marie-Marthe, Cran à Gagnon, Anse du Colombier, Anse à Norbert, Anse Noire, Îlets Jérémie, Réserve Pessamit Sud, Pointe-aux-Outardes Est and Ouest and Baie Saint-Nicolas.

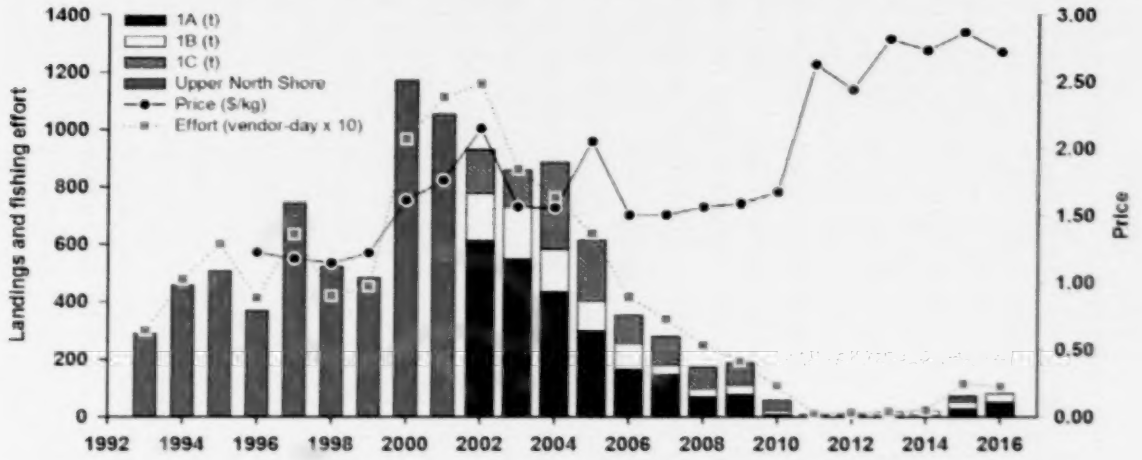

Figure 4. Commercial landings (t) of softshell clams by sub-area and average price ($/kg) and fishing effort (vendor-day) for all of the Upper North Shore.

Since their introduction in 2015, TACs have not been met for the vast majority of areas, despite a high price since 2011. The TAC was reached in one part of sub-area 1A in 2015, which was Cran à Gagnon, and in three areas in 2016: Cran à Gagnon, Anse à Norbert and Anse Noire.

After heavy exploitation of Upper North Shore beds occurred from 1997 to 2004, landings from several significant beds sharply declined (Pointe de Mille-Vaches, Pointe à Boisvert, Baie des Chevaux, Banc Marie-Marthe, Réserve Pessamit Sud and Pointe-aux-Outardes). Despite the break in recent years, several areas have not shown significant improvement in the status of their resources.

On the Upper North Shore, the fishing effort has fallen from 11,586 vendor-days in 2002 to 1,942 vendor-days in 2009, a drop of 83% (Table 2 and Figure 4). In 2001 and 2002, despite a considerable effort and a higher price than in 2000, landings began to dwindle. Since 2004, the decline in effort is likely due to the decrease in the number of commercial harvesters involved in this fishery. Since 2006, landings have been modulated by fishing effort.

Table 1. Softshell clam commercial landings (t) from 2002 to 2016 and total allowable catches (TACs, t) from 2015 and 2016 by shellfish area in the Upper North Shore and cumulative landings by region.

Sub-area	Area or region	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	TAC
1A	Baie des Petites Bergeronnes	16	32	26	115	-	-	1	-	9	-	-	-	-	-	-	-
1A	Baie des Grandes Bergeronnes[1]	-	22	100	-	75	28	14	18	-	-	-	-	-	-	-	-
1A	Baie des Escoumins[1]	-	-	-	-	-	62	11	22	-	-	-	-	-	-	-	-
1A	Iles Penchées	5	5	7	2	6	-	-	-	-	-	-	-	-	-	0.3	5
1A	Pointe à Boisvert	125	49	24	21	12	4	1	0.5	-	-	0.1	-	-	-	-	20
1A	Pointe de Mille-Vaches	32	137	62	20	8	2	0.1	3	-	-	-	-	-	-	-	20
1A	Baie des Chevaux	82	59	45	27	10	4	5	2.7	1	0.7	2	2	0.6	2	10	20
1A	Banc Marie-Marthe	223	118	49	11	13	11	13	12	1	0.7	0.3	1	2	16	18	30
1A	Baie Didier Sud	3	19	12	8	5	2	0.2	0.7	-	-	-	-	-	-	2	-
1A	Baie des Plongeurs	30	17	27	32	18	4	0.5	-	-	-	-	-	-	-	3	-
1A	Batture aux Gibiers	2	3	1	-	-	-	0.4	-	-	-	-	-	-	-	1	0.5
1A	Cran à Gagnon	27	14	7	3	2	2	1	0.1	-	-	< 0.1	< 0.1	0.4	8	5	5
1A	Rivière Blanche[1]	-	24	5	-	-	13	11	11	-	-	-	-	-	-	-	-
1A	Anse du Colombier	10	17	23	22	5	4	3	2	-	-	-	< 0.1	0.1	2	3	10
1A	Anse à Norbert	13	0.4	1	0.2	2	0.6	0.2	-	0.1	-	-	0.1	0.1	-	1	1
1A	Anse Noire	4	2	4	4	2	1	< 0.1	0.2	-	-	-	-	-	< 0.1	1	1
1A	Îlets Jérémie	31	23	30	35	9	12	8	11	9	-	0.1	< 0.1	0.4	0.1	6	15
1A	Other areas[2]	< 0.1	9	10	-	1	0.6	-	-	-	-	-	-	-	-	-	1.4
1B	Pointe-aux-Outardes Ouest et Est	150	154	136	79	71	31	26	27	9	10	10	14	19	22	26	30
1B	Rivière Mistassini	4	3	2	5	5	-	-	0.1	-	-	-	-	-	-	-	3
1B	Baie Saint-Nicolas	10	15	10	17	9	-	-	-	-	-	-	1	0.1	-	0.1	1
1B	Other areas[3]		8	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1C	Réserve Pessamit Sud	154	129	304	214	100	98	80	82	38	-	-	-	-	21	5	50
	Upper North Shore	930	859	886	614	354	279	176	190	67	11	12	19	23	72	83	-
	Sub-area 1A	613	499	318	299	92	46	34	29	20	1	2	3	4	29	52	-
	Sub-area 1B	163	172	148	101	87	31	26	27	9	10	10	15	19	22	26	-
	Sub-area 1C	154	129	304	214	100	98	80	82	38	-	-	-	-	21	5	-
	Depuration[1]	-	59	115	-	75	103	36	51	-	-	-	-	-	-	-	-
	Îles-de-la-Madeleine	-	-	-	0.1	0.4	0.5	1.0	0.5	0.9	0.1	0.8	1.2	1.3	0.8	0.7	-
	Other regions[4]	98	24	-	0.4	-	0.5	-	-	-	-	-	-	-	-	-	-
	Québec (total)	**1,028**	**883**	**886**	**615**	**354**	**280**	**177**	**190**	**67**	**11**	**13**	**20**	**24**	**73**	**84**	-

[1] Limited status area (depuration).
[2] Baie de Tadoussac (depuration), Batture à Théophile, Saint-Paul-du-Nord and Pointe à Émile.
[3] Baie Saint-Ludger and Anse à Frigault (depuration).
[4] Middle North Shore and Gaspé–Lower St. Lawrence.

Table 2. Commercial fishing effort (vendor-days) for clams by shellfish area for the Upper North Shore and cumulative effort by region.

Sub-area	Area or region	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1A	Baie des Petites Bergeronnes	200	369	283	1,050	-	-	9	-	-	-	-	-	-	-	-
1A	Baie des Grandes Bergeronnes[1]	-	41	193	-	621	276	137	178	-	-	-	-	-	-	-
1A	Baie des Escoumins[1]	-	-	-	-	-	458	124	200	-	-	-	-	-	-	-
1A	Iles Penchées	79	72	92	36	98	-	-	-	-	-	-	-	-	-	4
1A	Pointe à Boisvert	2,425	861	379	298	231	77	50	6	-	-	7	-	-	-	-
1A	Pointe de Mille-Vaches	390	1,640	802	294	152	39	2	-	-	-	-	-	-	-	-
1A	Baie des Chevaux	744	575	423	220	121	43	65	25	14	9	33	25	9	26	110
1A	Banc Marie-Marthe	2,293	1,089	438	117	149	139	114	111	10	10	13	21	29	160	192
1A	Baie Didier Sud	57	212	123	83	51	26	4	7	-	-	-	-	-	-	19
1A	Baie des Plongeurs	405	207	285	278	266	62	5	-	-	-	-	-	-	-	27
1A	Batture aux Gibiers	24	25	12	-	-	-	5	-	-	-	-	-	-	-	9
1A	Cran à Gagnon	336	194	77	61	33	33	20	2	-	-	1	1	6	95	65
1A	Rivière Blanche[1]	-	105	22	-	-	133	108	99	-	-	-	-	-	-	-
1A	Anse du Colombier	177	202	245	211	87	72	53	31	-	-	-	1	3	34	73
1A	Anse à Norbert	140	2	17	2	27	11	4	-	2	-	-	4	5	-	29
1A	Anse Noire	45	32	53	34	28	17	1	7	-	-	-	-	-	2	10
1A	Îlets Jérémie	335	264	270	284	87	132	77	84	51	-	4	3	5	1	45
1A	Other areas[2]	1	140	26	-	13	11	1192	-	-	-	-	-	-	-	-
1B	Pointe-aux-Outardes Ouest et Est	1,655	1,230	1,341	821	605	343	-	297	79	111	100	122	197	204	350
1B	Rivière Mistassini	39	22	9	41	53	-	-	-1-	-	-	-	-	-	-	-
1B	Baie Saint-Nicolas	76	147	100	123	64	-	-	-	-	-	-	12	2	-	3
1B	Other areas[3]	-	21	-	-	13	-	-	-	-	-	-	-	-	-	-
1C	Réserve Pessamit Sud	2,165	1,158	2,448	2,409	1,468	1,514	484	894	927	-	-	-	-	644	118
	Upper North Shore	11,586	8,614	7,638	6,362	4,167	3,386	2,494	1,942	1,083	130	158	189	256	1,166	1,054
	Sub-area 1A	7,651	5,835	3,506	2,968	1,343	651	439	273	77	19	58	55	57	318	583
	Sub-area 1B	5,835	1,399	1,450	985	735	343	494	298	79	111	100	134	199	204	353
	Sub-area 1C	3,506	1,158	2,248	2,409	1,468	1,514	1,192	894	927	-	-	-	-	644	118
	Depuration[1]	-	222	234	-	621	878	369	477	-	-	-	-	-	-	-
	Îles-de-la-Madeleine	-	-	-	5	36	26	55	47	28	8	32	40	62	56	54
	Other regions[4]	556	137	-	1	-	1	-	-	-	-	-	-	-	-	-
	Québec (total)	**12,142**	**8,751**	**7,638**	**6,368**	**4,203**	**3,413**	**2,549**	**1,989**	**1,111**	**138**	**190**	**229**	**318**	**1,222**	**1,108**

[1] Limited status area (depuration).
[2] Baie de Tadoussac (depuration), Batture à Théophile, Saint-Paul-du-Nord and Pointe à Émile.
[3] Baie Saint-Ludger and Anse à Frigault (depuration).
[4] Middle North Shore and Gaspé–Lower St. Lawrence.

Annual average catch per unit effort (CPUE, kg/vendor-day) was calculated by shellfish area (Table 3). The reference average for the period 2002 to 2015 ranged from 52 to 97 kg/vendor-day, depending on the area. In 2015 and 2016, average CPUEs were over this reference average in the areas Baie des Chevaux, Banc Marie-Marthe, Baie Didier Sud, Baie des Plongeurs, Batture aux Gibiers, Cran à Gagnon, Anse Noire and Îlets Jérémie and under the reference average in the areas Anse du Colombier, Anse à Norbert, Réserve Pessamit Sud and Pointe-aux-Outardes.

Table 3. Catch per unit effort (kg/vendor-day ± 95% confidence interval) in 2009 to 2016 and reference average (Avg) for the period 2002-2015 by shellfish area for the Upper North Shore.

Shellfish area	2009	2010	2011	2012	2013	2014	2015	2016	Avg
Pointe à Boisvert	76 ± 37	-	-	21 ± 7	-	-	-	-	52
Baie des Chevaux	109 ± 23	76 ± 17	79 ± 36	55 ± 8	94 ± 21	67 ± 16	94 ± 29	94 ± 13	88
Banc Marie-Marthe	109 ± 8	136 ± 76	69 ± 15	24 ± 17	53 ± 23	75 ± 17	106 ± 9	96 ± 9	89
Baie Didier Sud	104 ± 55	-	-	-	-	-	-	111 ± 26	84
Baie des Plongeurs	-	-	-	-	-	-	-	123 ± 13	89
Battures aux Gibiers	-	-	-	-	-	-	-	135 ± 36	73
Cran à Gagnon	-	-	-	-	-	65 ± 12	89 ± 9	81 ± 6	70
Anse du Colombier	67 ± 12	-	-	-	-	-	61 ± 6	50 ± 12	70
Anse à Norbert	-	-	-	-	-	24 ± 8	-	41 ± 7	70
Anse Noire	22 ± 10	-	-	-	-	-	-	95 ± 43	69
Îlets Jérémie	128 ± 12	134 ± 23	-	16 ± 7	-	71 ± 6	-	130 ± 17	97
Rés. Pessamit Sud	86 ± 4	44 ± 4	-	-	-	-	34 ± 1	42 ± 5	74
PAO Ouest et Est[1]	89 ± 8	96 ± 15	86 ± 8	96 ± 9	118 ± 8	83 ± 4	82 ± 4	60 ± 5	94
Baie Saint-Nicolas	-	-	-	-	88 ± 24	-	-	-	-

[1] Pointe-aux-Outardes.

The clams harvested in the various shellfish areas are measured at the processing plant (when landed). The average size of clams landed by area ranged from 58 to 68 mm in 2015 and 58 to 74 mm in 2016 (Table 4). The lowest averages (≤ 60 mm) were observed in the areas of Îles Penchées, Anse du Colombier, Anse à Norbert, Anse Noire and Baie Saint-Nicolas. The proportion of clams of sub-legal size (< 51 mm) was often associated with low average sizes. This proportion has generally remained below 5% (Table 4). Proportions of 12% were observed at Anse du Colombier in 2015 and 9-10% at Anse du Colombier, Anse Noire, Îles Jérémie and Baie Saint-Nicolas in 2016.

Particular attention was paid to commercial harvesting in Baie Didier Sud and Baie des Plongeurs. These two areas were closed in 2010 because the clams sold had an average size near or under the minimum legal size of 51 mm (Table 4). In 2016, the area of Baie Didier Sud was opened to commercial harvesting over a period of good tides (7 days) and the Baie des Plongeurs over two periods (13 days). The average size of clams landed was 61 mm at Baie Didier Sud and 64 mm at Baie des Plongeurs, values significantly higher than those measured before the closing.

Research indices

Surveys were carried out in 2014 in the Réserve Pessamit Sud and in 2016 in Banc Marie-Marthe and the Baie des Plongeurs. These surveys provide essential information on the size of the bed, the distribution of clams, demographic structure, recruitment to the fishery, abundance and exploitable commercial biomass.

Table 4. Average size (mm) of clams landed, proportion under the legal size (%, in parentheses) from 2007 to 2016 and average reference size (Avg) for the period 2004-2015 by shellfish area for the Upper North Shore.

Shellfish area	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Avg
Îles Penchées	-	-	-	-	-	-	-	-	-	58 (7)	-
Pointe à Boisvert	60 (14)	58 (25)	-	-	-	67 (0)	-	-	-	-	60
Pointe de Mille-Vaches	66 (3)	58 (9)	-	-	-	-	-	-	-	-	-
Baie des Chevaux	59 (9)	59 (10)	56 (17)	-	-	67 (0)	-	-	60 (7)	65 (2)	59
Banc Marie-Marthe	64 (10)	62 (11)	62 (7)	-	-	-	-	-	65 (1)	65 (2)	62
Baie Didier Sud	53 (35)	-	52 (45)	-	-	-	-	-	-	61 (4)	51
Baie des Plongeurs	54 (32)	50 (57)	-	-	-	-	-	-	-	64 (1)	52
Battures aux Gibiers	66 (7)	-	-	-	-	-	-	-	-	64 (3)	66
Cran à Gagnon	57 (14)	60 (5)	58 (17)	-	-	-	-	-	59 (4)	62 (1)	56
Anse du Colombier	-	53 (33)	57 (13)	58 (3)	-	-	-	-	58 (12)	58 (10)	57
Anse à Norbert	-	52 (39)	-	-	-	-	-	-	-	60 (3)	52
Anse Noire	-	-	-	-	-	-	-	-	-	58 (10)	-
Îlets Jérémie	-	55 (21)	56 (22)	64 (1)	-	-	-	-	-	61 (10)	61
Rés. Pessamit Sud	61 (13)	58 (21)	59 (16)	62 (9)	-	-	-	-	65 (3)	74 (0)	62
PAO Ouest et Est[1]	70 (3)	69 (6)	71 (6)	74 (1)	74 (0,3)	69 (1)	66 (4)	66 (4)	68 (5)	70 (4)	70
Baie Saint-Nicolas	-	-	-	-	-	-	-	-	-	60 (9)	53

[1] Pointe-aux-Outardes.

The sampling plan used in 2014 at Réserve Pessamit Sud was the same as that used in 2005 and 2010 on the same bed. The size of the bed was estimated at 1.4 km^2. The results suggest stability of the density and biomass of commercial-sized clams and pre-recruits (25-50 mm) compared to the survey of 2010 (Table 5).

Table 5. Results obtained by size class during the survey of Réserve Pessamit Sud shellfish area in 2005, 2010 and 2014.

Year	Density (number/m^2 ± se)		Abundance (10^6 individuals)	Yield (g/m^2 ± se)		Biomass (t)
	25-50 mm	≥ 51 mm	≥ 51 mm	25-50 mm	≥ 51 mm	≥ 51 mm
2005	36.6 ± 11.6	19.2 ± 3.9	27	206 ± 60	527 ± 91	738
2010	20.7 ± 5.7	12.2 ± 2.0	17	151 ± 45	357 ± 54	499
2014	15.8 ± 3.8	12.9 ± 2.5	18	92 ± 23	397 ± 73	555

The results of surveys conducted in 2016 in the Banc Marie-Marthe and Baie des Plongeurs areas are preliminary. About 30 planned stations could not be carried out in 2016. These surveys will be completed in March 2017. However, the closure of Baie des Plongeurs from 2010 to 2015 appears to have favoured the recovery of this bed.

Exploitation rate indicators

From 2002 to 2014, six shellfish areas were surveyed in the Upper North Shore. In reporting the landings based on the biomass estimated for commercial-sized clams for each area, it is possible to calculate an exploitation rate index. High exploitation rates of more than 15% were estimated at Pointe à Émile in 2003, Baie des Chevaux in 2002, Anse Noire in 2003 and Réserve Pessamit Sud in 2005 (Figure 5). These years correspond to a period when the exploitation was significant in the Upper North Shore, which was followed by a sharp drop in landings (Table 1). Conversely, the exploitation rate under 10% observed in other sectors in 2007, 2010 and 2015 seems to be associated with maintaining landings (Figure 5). Other

indicators (e.g. Leslie 37% exploitation rate calculated in 2007 at Baie des Escoumins) also suggest that an exploitation index exceeding 10% is not sustainable in the long term for softshell clams.

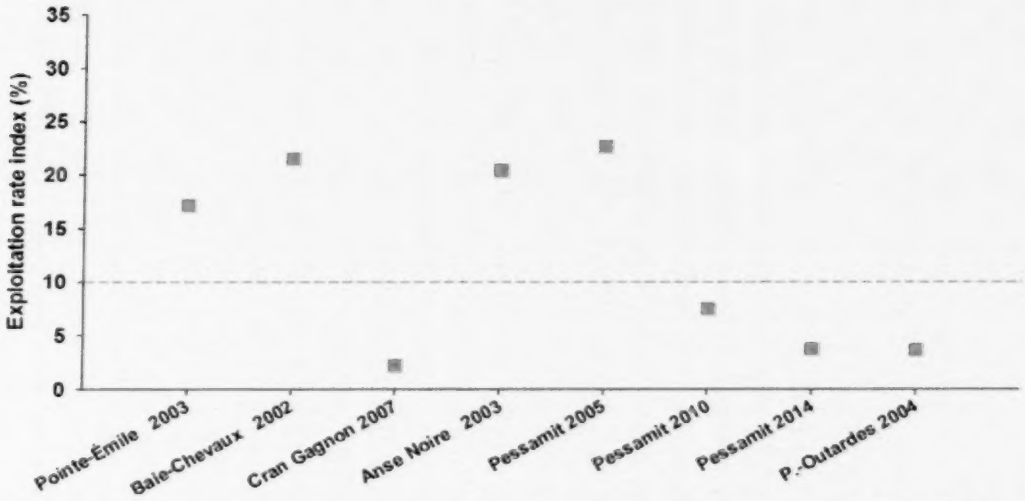

Figure 5. Exploitation rate index (ratio between landings and commercial biomass available) estimated per year for certain shellfish areas of the Upper North Shore.

The TAC set in 2015 only applies to commercial harvesting. Recreational harvest catches are not recorded in the cumulative landings. To maintain the reproductive potential of each bed, annual catches should not exceed 10% of the commercial biomass for the Upper North Shore softshell clam populations.

Sources of uncertainty

Sharing the territory between commercial and recreational harvesters, combined with the lack of information from the recreational component, makes it difficult to assess the landings and total effort on the various beds in the Upper North Shore.

There was a certain level of uncertainty in the interpretation of CPUEs. While fishing effort used is expressed in vendor-day, the actual number of harvesters involved is unknown. In addition, the harvester/seller ratio may have changed over the years, primarily between the period of the early 2000s when fishing was intensive, and recent years. In this case, the CPUE could reflect performance or the number of harvesters and not the status of the resource. The absence of independent indicators for the commercial component means that advisory reports about softshell clams are dependent upon information coming from the commercial fishery alone.

Environmental variations (weather conditions or abnormal tidal ranges) can also affect some fishery indicators, such as fishing effort and CPUEs. In addition, the increasing frequency of storm surges, shoreline erosion and reduced ice cover are also variables that could have a negative impact on softshell clam populations, on the recovery of certain beds, especially those in sandy sediments, and on recruitment to the population.

The cumulative effects of these various sources of uncertainty could lead to advisory reports that do not completely reflect the status of the resource.

CONCLUSIONS AND ADVICE

Since the last assessment of softshell clam stocks in 2011, landings and fishing effort have been low in the Upper North Shore, particularly because of processing plant closures. Despite the re-opening of a plant in 2015 and good prices, landings remained poor. For the vast majority of shellfish areas, the TAC was not reached in 2015 and 2016. This low fishing effort could be due to a decrease in the resource or socio-economic factors (e.g. difficulty in recruiting commercial harvesters).

The interest of harvesters in some sectors (e.g. Pointe de Mille-Vaches and Pointe à Boisvert) has greatly decreased since 2005. This lack of interest from harvesters could be explained by low yields, indicating a low biomass of commercial-sized softshell clams on these beds. Recovery of clam populations in some areas, particularly those with sandy sediments, could be compromised by environmental phenomena, such as bank erosion.

In the absence of specific information on the source of recruitment to the population on the various beds, it is recommended to protect the reproductive potential of each shellfish area. To do this, it is recommended to annually harvest less than 10% of the commercial biomass estimated from surveys.

Also, to mitigate the incidental mortality caused by the fishery, it is recommended to prohibit any harvesting when the air temperature is ≤ 0 °C.

It would be a good idea to continue the surveys of commercially harvested beds in order to determine their potential and productivity. The information gathered would make it possible to adjust the TAC to the reality of each bed. In addition, the acquisition of data on recreational harvesting is required to assess its impact on the resource.

OTHER CONSIDERATIONS

The recommended conservation measures for clams are aimed at preserving the capacity of each bed to regenerate itself. Any approach aimed at maintaining or even increasing the reproductive potential of each shellfish area, either by leaving more adults on the bottom or by creating refuge areas, will have a positive impact on resource conservation. In addition, as the production of gametes is proportional to the length of the clam cubed, there will be a net gain in productivity by allowing individuals to grow.

The design of a harvesting plan and enhancement activities (e.g. collection, density adjustment and stocking) of the harvested populations would increase the productivity of this resource.

Finally, timely environmental events (e.g. breaking waves, storms) and shoreline erosion can have a major impact on the clam beds and completely reshape their habitat. These effects may also differ from one bed to another. The acidification of the water and changes in salinity could also affect the progress of larvae, juveniles and adults. It would be appropriate to monitor the status of the ecosystem, to detect any changes that could affect directly clam populations.

With the setting of TAC levels, it is becoming important to establish decision-making rules in the coming years to allow for a TAC adjustment in the medium term.

Stock Status Indicators

The stock status assessment of softshell clams is done every three years. For the moment, no monitoring process is being considered for the intervening years. However, a TAC adjustment could be done taking into account abundance indicators from new surveys of clam beds.

SOURCES OF INFORMATION

This Science Advisory Report is from the meeting of February 16, 2017, on the Assessment of Quebec inshore waters Softshell clam. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

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